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Which Parts of a Clinical Process EPR Needs Special Configuration

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Abstract

Subject: *Which parts of an electronic patient record (EPR) can initially form a stable standard solution to be used by all clinicians? And which parts of an EPR can we predict needs initial as well as on-going re-configuration to meet the needs from diverse medical specialties.*

Purpose: *To analyze which screen types in a clinical process that can be standard configured and which are subject to initial as well as on-going re-configuration.*

Methods and results*: A pilot-project implementing a fully functional clinical process EPR was configured and used at a neurological ward, replacing all paper records 24/7. The analysis characterizes the different types of screens, a total of 243 included in the EPR solution. All screens have been extracted from the application and analyzed for changes in total 222 changes.*

Discussion and conclusion: *Most screens (87%) are very stable. Few (13%) are subjected to several re-configurations and they stabilize after an average of six iterations: Some may further stabilize over time since they address new but also general ways of working. Other screens relate to the specific medical specialty and cannot be part of a standard solution.*

Keywords:

integrated advanced information management systems, software design, interprofessional relations, user-computer interface, problem-oriented medical records

Introduction

Clinical Process form a core module of an Electronic Patient Record (EPR) that supports clinical documentation and decision making and comprises the on-going documentation of medical patient information made by the clinical staff (physicians, nurses, therapists, medical secretaries, etc.). It is hard to imagine that one single standard configuration would be optimal for all clinicians throughout the hospital: The clinicians at the neurological ward needs patient overviews focusing at parameters addressing cerebral haemorrhage and cerebral stroke while the clinicians from for example psychiatry needs completely different data and information in their patient overviews. Much basic patient data however (e.g. address information, family relations, drug profile, previous diagnosis, etc.) as well as functionality for common data entries (e.g. temperature, blood pressure, drug prescriptions, etc.) might be presented in a uniform way through standard screens used by all clinicians regardless of their medical specialties.

Modern EPR platforms today support international health standards (e.g. HL7), terminologies (e.g. SNOMED CT), and database platforms (e.g. Oracle HTB) while at the same time offering a high degree of configurability by means of e.g. XML-based templates. EPR technologies has reached a level where EPRs can be developed as a standard tool for all clinicians while the EPR at the same time can be configured to serve as a tool customized for specific needs supporting the high level of specialization that each clinical specialty represents. A main question that hospital managers and EPR developers face is thus the research question of this article: *Which Parts of a Clinical Process EPR Needs Special Configuration?*

The article is based on a project where a fully functional clinical process EPR was configured and used at a neurological ward, replacing all paper records 24 hours a day throughout a pilot lasting one week. We have analyzed how each of the EPRs 243 screens was configured and reconfigured to meet the needs of the clinicians. Based on this study we are able to indicate: 1) Which parts (screens) of an EPR that initially might be developed as a stable standard solution and used by all clinicians throughout many hospitals (no or few further re-configurations are to be expected when the EPR is rolled out to other wards); and 2) which parts of an EPR we can predict needs initial as well as on-going re-configuration to meet the needs from clinicians representing diverse medical specialties (e.g. neurology, surgery, gynaecology, psychiatry, etc.)?

In the following we introduce the study and the method used for the analysis. Then we present the results in terms of our categorization of screen types and the completed as well as requested re-configurations for each type. Finally we discuss and conclude our findings, the limitations of the study and the implications for practice and research.

The clinical process EPR project

The project was part of a research project on effects-driven IT development [1] (http://Effects-DrivenIT.dk) and was formed by 3 partners: Clinicians from the neurological stroke unit and project managers from the EPR unit at Roskilde County Hospital, researchers from the Department of Communication, Business and Information Technologies at Roskilde University and business architects from the vendor, CSC Scandihealth A/S. One main aim of the project was to experience how to configure a clinical process EPR module in participation with clinicians and to test how a configured solution would work in a real clinical process.

The project involved a neurological stroke unit treating patients with acute apoplexy where all paper-based patient

records were replaced with a configured and fully functional prototype EPR system. The aim was to evaluate an EPR with complete patient records tested on-line on real clinical processes [2, 3]. The project thus required thorough planning involving development of new EPR-supported patient trajectories, configuration and implementation of all screens needed in the EPR system, real-time integration with other systems, migration of patient data, and training of the clinical staff in using the system and working according to the revised patient trajectories.

The content of the EPR was identified during three workshops, i.e. the structure, content and placement of clinical notes and result templates, standard plans, concept lists etc. At the final workshop the complete specification was presented and reviewed before the actual configuration of the XML-based templates and load of the templates to the EPR. During this process the content of the EPR was elaborated in up to three iterative events. First, mock-ups were drawn on flip-over paper. Secondly, a preliminary non-interactive prototype was discussed. Finally, a running prototype was demonstrated, discussed, and evaluated. The vendor undertook the technical development of the prototype, along with interfaces to various legacy systems currently used at the hospital (ADT system, laboratory system, and medication module). A number of tests and re-configurations of the system were made in parallel with training the clinical staff in using the prototype. A final rehearsal was performed by testing the system under laboratory conditions using real patient-cases in a scenario setup on the solution that was due for release in the pilot. This was the final reassurance within the project team that the EPR was ready.

The most complicated part of the screens concerned those that should provide the clinical staff the ability to efficiently obtain overview and assessment of patients as well as on more efficient coordination in three specific and highly cooperative situations:

Nursing handover, which happens three times a day at the beginning of each nursing shift (7am, 3pm, and 11pm) and last about an hour. There is no time for the nurses that leave the ward to discuss patients with the nurses on the next shift. During the nursing handover, one nurse is designated as the team leader and provides an overview of the patients at the ward and manages the necessary coordination and exchange of information. This nurse reviews the patient records and orally informs the others about status and plans for the shift.

Team conference, which takes place once every weekday, lasts approximately 15 minutes, and includes all clinical staff members (physicians, nurses, and therapists). An interdisciplinary assessment of each patient is carried out and plans are revised. The current status of each patient is given orally by a nurse and an overview of current plans is available by means of a table on a large whiteboard or, in the prototype EPR system, a full screen projected on the wall.

Medical ward round, which happens once every weekday and lasts for three to six hours. It includes evaluation, reviewing, and discharging of patients. The chief physician visits all patients and reviews the plans for their treatment. Usually there is no time for nurses to follow the physician during the ward round. Information exchange and coordination is obtained through the patient record and by ad hoc communication with the nurses on shift.

The required content was configured as XML-based templates that were loaded into the clinical framework tool, CSC Clinical Suite, based on the Oracle Healthcare Transaction Base (HTB). CSC Clinical Suite is not an EPR per se, but a clinical framework tool that can contain and present the clinical content as specified by the clinicians by use of XML-based tem-plates for overviews, clinical notes, results, standard plans, work situations and structure of the patients medical record. This makes it possible to configure a complete medical record in accordance with the clinicians requirements and is able to evolve dynamically as new requirements emerge.

In the final part of the project (the pilot), the configured EPR system was online 24 hours a day and replaced the paper-based records for all patients during one week in December 2005. Five years of patient data (in total more than 26 million data records from more than 300.000 patients) had been migrated to the EPR system and interfaces were established to the legacy systems in order to receive updated data during the project. The EPR system included screens projected on the wall during nursing handovers and team conferences, stationary and portable PCs, and PDAs used for obtaining measurements at the patients bedside (temperature, blood pressure, etc.). All clinicians used the EPR system during the pilot. Management oversaw to the project ensuring both legal requirements and patient-ethics were respected.

Data analysis method

All screens in the EPR solution 243 in total have been extracted from the application and analyzed for changes 222 in total made in the project period. The analysis is based on the vendors systematic documentation of all the changes made to each screen, from an initial first version of a screen and throughout the project period including the pilot where the system was used 24 hours a day.

In order to analyse the screens they have been categorized as follows. The screens have been divided into general and specific screens. A general screen can serve the same purpose on any medical ward: E.g. screens for recording basic vital values such as blood pressure, pulse and temperature might be the same on a medical and a surgical ward. Specific screens serve a special purpose within the given clinical speciality: E.g. screens for recording and monitoring a SIP score (Stroke In Progress) are specific to the Neurology speciality.

All screens in the EPR system (as well as in information systems in general) can be divided into two different categories, as either a form or a view:

- Form, resembling a paper form for *recording* (registration and submitting) data. This can be free-text or structured information in various degrees. Typical forms could be observations, notes, and basic vital values.
- View, is the *presentation* of data either recorded in the EPR system or received from external systems. A view retrieves data from one or several sources and presents it as information to the user or as an indexing service.

Typical information views could be: Graph presentation of basic vital signs, or overviews' creating information bulletin boards with focused information for a specific clinical situation (including e.g. nursing handover, team conference, and medical ward round). Views also include Journal structure views that present the user with all available data in a structure for navigation. This navigation hierarchy was designed to resemble that of the paper record.

In order to determine who made decisions regarding changes we assigned each view or form a primary user in terms of professional discipline (doctor, nurse, therapist or shared by doctor & nurse). This is to indicate the coordination involved among professional groups in the design and implementation process.

All changes analyzed were changes that were actually implemented. Several change request where also collected but not implemented because they were considered non-essential (nice-to-have as opposed to need-to-have) to the continued use of the system during the pilot. The changes made to the screens were analyzed with regard to when they occurred in the project (before, during or after completion of pilot). Types of changes include content (new fields in forms, new selections in views, labels changed); rules (business logic, validations); computations (adding or changing calculation functionality); and cancelled (retirement of screens due to time pressure or obsolescence due to other screens delivering similar services). The changes are summarized into 3 major groupings:

- None (0): No changes were necessary.
- Few and initial changes (1-2): One or two changes were made initially in the project during the prototyping process. These types of changes reflect a low complexity or uncertainties in design.
- Several and sustained changes (>2): More than two changes occurring including changes beyond the initial prototyping process. These changes reflect either uncertainty among clinicians or complexity in the implementations. It also reflect screens that needs to be configured by an *experimental* approach which entail several successive changes throughout the project, in some cases including changes made within the pilot period.

Based on the categories listed above all screens and changes were analysed and the resulting patterns are presented below.

Results

We have identified a number of interesting patterns with regard to the changes made to the screens representing the overall configuration (and re-configuration) of the clinical process EPR system. The implementation resulted in an EPR with a 4:1 ratio between forms and views. Less than 10% of the total 243 screens were specifically configured to the neurological specialty (16 out of 183 forms and 7 out of 60 views).

The majority of screens (87%) were not changed at all or only subject to few initial changes (table 1). Thus the major part of the total system may be considered as being quite stable. These stable screens were both medical specific forms (45%, 7 out of 16 totals) and general forms (90%, 152 out of 167 totals). Most of the stable forms were quite simple, in terms of containing only one or two data fields (e.g. registration of simple results like blood glucose) and often they were serving as a sub-template in larger and more complex forms. Views that present data from other systems were also very stable, e.g. views presenting X-ray results. Another characteristic for stable forms and views was that only one professional discipline was involved as main user, or the design was known from other systems as e.g. views presenting aggregated laboratory-results.

Distribution among screens changed

Total screens	**None (0)**	**Few and initial (1-2)**	**Several and sustained (>2)**
243	184	27	32
100%	76%	11%	13%

Table 1 - Changes made to the screens during the entire project.

The total number of changes accounts to 222. Out of these 83% (184 changes) were made to the 32 screens that received more than 2 changes each. This verifies that the configuration of 13% of the screens (32 out of 243) reflects a need for experimentation. These screens where subjected to a more thorough analysis and present interesting change patterns as seen below in table 2 and 3.

Screen change pattern specific vs. general

	Specific		**General**	
	Screens	Changes	Screens	Changes
Form	7	39	15	79
View	5	38	5	28
32	12		20	
184		77		107

Table 2 - Analysis of the 32 screens subjected to several and sustained changes (from table 1) distributed among screen requirements attributed to the specific neurology speciality or of a general clinical nature.

Screen change pattern among professional disciplines

	doctor	**nurse**	**multi**
Form	5	14	3
View	0	3	7
32	5	17	10

Table 3 - Analysis of the 32 screens to support either a professional discipline (doctor or nurse) or information collaboration among disciplines (multi).

Content changes where dominant in these patterns (82%, 184 out of 222 total changes), including adjusting labels on fields, adding new fields, removing obsolete fields, in some cases later to be added again. The need for experimentation grew according to the complexity of views, for example as more than one professional discipline was identified or data had to be drawn from several forms.

Motivations for changes in forms where often driven by their dependency to deliver data in the views. If for example a view is changed to include additional data this often entail that a form needs change in order to capture this data. Changing one view sometimes indirectly contributed to changes made in index-views that display a structure for navigating the various documentation models in the EPR. The scenario would typically be that each time a new view was available, it also had to be accessible without the search functionality, and this sometimes entailed that a logic entry or indexing in the Journal structure had to be assigned adding to changes accumulated by this index-view.

If we focus on the 32 screens from table 1 that were subject to several and sustained changes and display the results in table 2 and 3, we observe that the general forms are in majority to the general views (3:1). They are primarily owned by only one group of professionals (19 out of 22 have only one profession as primary owner). The nurses account for 11 out of 15 general forms shown in table 2 which also sparks attention to why they are represented with so relative many forms?

The views are equally distributed among specific and general, but are characterized by having more than one owner (7 out of 10, see table 3). Specific forms include forms for clinical plans with regard to stroke, which in the project constituted an entirely new way of applying their knowledge. These plans account for 4 out of 7 Specific Form screens shown in table 2, and 25 of 39 changes made to these screens.

Common factors contributing to changes among all the 32 screens has been identified as complex computations required on the client side, specific forms (e.g. Scandinavian Stroke Scale), or views (both specific and general) involving multiple professional disciplines where forms and views should support coordination of data or tasks. Especially when supporting an inter-disciplinary approach to EPR: E.g. complex views supporting the ward round or the team conference draw on information from radiology systems and clinical laboratory systems, and in addition including observations and notes made by doctors, nurses, and therapists.

The fact that the systems delivered 24/7 service during the pilot could entailed that only needed changes were implemented during the pilot (need-to-have changes as opposed to nice-to-have changes). During the pilot a few changes were deemed necessary in order to continue efficient operations. These changes occurred only to 3 views while the remaining 240 screens (99%) remained unchanged. Nevertheless the pilot and the use of the EPR in general were evaluated as being successful and measurements on clinical practice using the EPR has documented several significant improvements [1, 2, 3].

Discussion

The results indicate patterns of changes displaying themes that are predominant in the process of designing and implementing the clinical process EPR. Our study indicate that the majority of a clinical process EPR does not require special configuration with, regard to the different clinical specialties, as 87% of all screens in the EPR remained stable by requiring no or only few changes. The stable screens include simple forms, views presenting data from other known systems as well as forms and views addressing only one professional discipline. Content changes where dominant representing 82% of all changes. A substantial part of the changes is a result of chain reactions, typically where a change to a view subsequently trigger other changes in related forms or views for navigating the EPR. Screens with more than 2 content changes account for 143 out of 222 in total or 64% in only 29 screens. They were often related, e.g. FORM; Stroke Scale, Apoplexy Observations relate to VIEW; Apoplexy Overview AND FORM; Apoplexy Plan. Approximately 3 times as many forms were needed as views giving an idea of how many forms are required to sustain views.

A number of screens was subjected to several and sustained changes reflecting a need for an *experimental* approach to the process of configuring the EPR. The configuration of these parts of the system addresses application areas where the EPR introduce new ways of working. Potentially this might result in far-reaching improvements by ways of efficient support of inter-disciplinary coordination among multiple professional disciplines. We can predict that some parts of this configuration will stabilize over time since they address new but also *general* ways of working with EPR. Other parts of this configuration addresses themes related to the *specific* clinical specialty which indicate parts of EPR that can hardly be standard configured to serve clinicians throughout the hospital.

Forms supporting new ways of structuring documentation and views presenting the journal structure are examples of general parts of the EPR that faced several and sustained changes.

In our study the doctors applied their existing documentation model to the EPR and they retained dictating as usual with the medical secretary entering the dictate into the EPR. The nurses on the other hand, had to invent and specify their documentation model and integrate it with the doctors model in the journal structure (it was a deliberate part of the project to experiment with adding structure to the nurses documentation). This resulted in a higher activity regarding the design of forms with nurses as professional discipline (as indicated in table 3). Throughout the project this sparked several general discussions among the nurses about how they where using the paper based journal structure and how to use EPR. They could see a new perspective with the EPR, and the need to evolve their documentation models to include how they decode clinical data into nursing information. In general it was a challenged to figure out how to merge multiple documentation models serving their interdisciplinary needs without compromising their professional knowledge to accommodate other professionals. E.g. the doctors did not have to give up describing the paμtients anamnesis from the diag-

nostic perspective, just because the nurses would insist on describing the anamnesis from a holistic perspective.

Views presenting the journal structure support navigating the EPR and provide an alternative to the pre-defined information clustering implemented in the overviews. This also provides the users with the possibility to verify, in case of uncertainty, if they had missed some information in the overviews. They came to rely on the patient-journal structure for completeness. The upper levels in the journal structure must be general throughout the hospital and this we can be predict to become relatively stable over time (though this was not the case in our study where introducing clinical process EPR). However the lower parts patient-journal structure hierarchy might become more specialized and susceptible to changes thereby requiring occasionally experimentation and dynamic technological solutions for the medical specialties.

The parts of the clinical process EPR where an ongoing and experimental configuration can be identified as addressing the *specific* clinical specialty comprises support for highly cooperative activities such as planning the patient treatment and activities such as team conferences and nursing handovers.

Planning was the primary contributor to many changes in the doctors group. Planning account for 4 out of 7 specific forms having sustained changes and 25 of 39 changes made to the specific forms included among the top 32 screens listed in table 2. This was due to the fact that many of the planning and coordination tasks traditionally are handled by other professionals (nurses or secretaries). The story repeats itself as with the nurses lacking a documentation model, since the doctors had no prior system to rely on. Plans can overall be divided into 2 categories: The initiating or basic plan and the follow-up or supplementing plan. It was relatively easy to design the initiating plans as they to a high degree resemblance with the department guidelines. However the follow-up proved more difficult as they where often conditional (e.g. if X-ray result is positive order antibiotics) or involved coordination of tasks between professional disciplines or other medical specialities. This complexity is contributed to the innovation requirements of the professionals as they become aware of one-anothers areas of responsibilities and explore the possibilities of coordinating and sharing information in new ways.

The views supporting the coordinating activities during team conferences and nursing handovers were also subject to sustained changes. Although not many in numbers, they account to a significant number of changes: 33% of all changes listed in table 2 and 3. The changes were primarily content changes to views supporting interdisciplinary cooperation (team conference) or single disciplines being derived from an entirely new documentation model nursing observations.

Conclusion

The majority of screens (87%), were stable and include simple forms, views presenting data from other known systems as well as forms and views addressing only one professional discipline.

Relatively few screens (13%, or 32 out of 243) were subjected to several re-configurations and a part of these may further stabilize in the future since they address new but also general ways of working. Another part are screens specific to the clinical specialty. There are indications that only few specific screens are necessary per medical speciality.

The screens with sustained change requirements include both general and specific screens and comprise different types of views displaying the potential of an EPR: They present new ways of decoding and sharing information and supporting highly cooperative activities. These screens are characterized by the clinicians having no previous experience from a mainly paperbased everyday work environment, or clinicians involved in multi-disciplinary content and cooperative activity. Our project documents that such screens can be efficiently configured through an experimental and participative approach [4]. It is also clear that it requires continuing the experimental approach to include using the EPR in a real clinical everyday work environment. From the technological point of view it sets the standards for how the EPR vendors must be ready to meet the dynamic requirements and where to expect more confidence in the stability of the EPR.

The perspective of our study gives an indication as to what to expect when engaging in the implementation of a dynamic EPR. This paper present the result of just one pilot-test, and more tests are necessary to investigate the issues of the dynamic versus stable parts of a clinical process EPR. We are now applying our experience from the pilot to new projects where several medical specialities are involved; neurology, cardiology and paediatrics across three different hospitals.

References

[1] Hertzum M and Simonsen J. Effects-Driven IT Development: Specifying and Measuring Usage Effects during Systems Development (forthcoming).

[2] Mller-Jensen J, Pedersen IL and Simonsen J. Measurement of the Clinical Usability of a Configurable EHR. In Hasman A et al. eds. Ubiquity: Technologies for Better Health in Aging Societies, Proceedings of the 20th International Congress of the European Federation for Medical Informatics (MIE 2006), Maastricht, the Netherlands, August 27-30. Amsterdam: IOS Press, 2006; pp. 356-361.

[3] Mller-Jensen J, Simonsen J, and Iversen RK. Measuring Effects on the Clinical Practice from a Configured EHR. In: Hejlesen O et al., eds. Proceedings of the 4th Scandinavian conference on Health Informatics (SHI 2006), Aalborg University, Aalborg, August 24-25. Aalborg: Virtual Centre for Health Informatics, 2006; pp. 58-62.

[4] Simonsen J and Hertzum M. A Regional PD Strategy for EPR Systems: Evidence-Based IT Development. In Jacucci G et al. eds. Expanding Boundaries in Design, Proceedings of the ninth biannual Participatory Design Conference, Vol. II (PDC 2006), Trento, Italy, August 1-5. Palo Alto: CPSR, 2006; pp. 125-128.

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